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DEEP WELLS FOR INDUSTRIAL WASTE INJECTION IN THE UNITED STATES

Summary of data

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Cincinnati, Ohio

November 1967

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DEEP WELLS FOR INDUSTRIAL WASTE INJECTION IN THE UNITED STATES

Summary of Data

Don L. Warner

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Cincinnati, Ohio

November 1967

In its assigned function as the Nation's principal natural resource agency, the United States Department of the Interior bears a special obligation to ensure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America -- now and in the future.

The WATER POLLUTION CONTROL RESEARCH SERIES of reports was established to describe the results of research studies of water pollution. This SERIES provides a central source of information on the intramural research activities of the Federal Water Pollution Control Administration in the U. S. Department of the Interior and on the research program's cooperative and contractual activities with Federal, State, and local agencies, research institutions, and industrial organizations.

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INTRODUCTION

The use of deep wells for disposal of some concentrated, relatively untreatable liquid wastes has increased in recent years and it is expected that this method will be widely applied in the future as water pollution control is emphasized.

It has come to our attention through our own research efforts and through contact with state agencies, industries, and individuals, that there is the lack of readily available current information regarding the location, design, and operating experience of existing industrial waste injection wells.

This publication lists 110 industrial waste injection wells and some of their characteristics. The data listed include:

1. Operator of well
2. Well location
3. Date of initiation of operation
4. A. Total well depth
   B. Depth of injection horizon(s)
   C. Geologic formations used for injection - rock type - formation age
5. Chemical and physical character of waste
6. Injection rate
7. Injection pressure (well head)
8. Source(s) of information

The information contained herein is believed to be generally accurate, but as indicated under sources of information, much of it was obtained indirectly and we have not yet, in most cases, attempted to verify it.

Detailed data on aspects of design, construction, and operation can be obtained for a number of wells from the references that are cited. Such additional information can also be obtained through inquiries to the individual companies and the appropriate state and federal offices.

SUMMARY

One hundred and ten industrial waste injection wells located in 16 states are described. Table 1 and Figure 1 summarize the contained information. The table shows that about 82 percent of the wells are used by chemical, petrochemical, and pharmaceutical product plants; refineries and natural gas plants; and metal product plants.

TABLE 1

STATISTICAL ANALYSIS OF INJECTION WELL DATA

DISTRIBUTION OF INJECTION WELLS BY INDUSTRY TYPE

Type of Industry	Percentage of Existing Wells
Refineries and Natural Gas Plants	20%
Chemical, petrochemical, and pharmaceutical companies	55%
Metal products companies	7%
Other	18%

TOTAL DEPTH OF INJECTION WELLS

Total Well Depth	Percentage of Wells
0 - 1,000 feet	5%
1,001 - 2,000 feet	32%
2,001 - 4,000 feet	27%
4,001 - 6,000 feet	28%
6,001 - 12,000 feet	6%
over 12,000 feet	2%

TYPE OF ROCK USED FOR INJECTION

Rock Type	Percentage of Wells
Sand	33%
Sandstone	41%
Limestone and dolomite	22%
Other	4%

TABLE 1 (CONTINUED)

RATE OF INJECTION	
Injection Rate	Percentage of Wells
0 - 50 gpm	23%
51 - 100 gpm	11%
101 - 200 gpm	25%
201 - 400 gpm	19%
401 - 800 gpm	3%
over 800 gpm	1%
unknown	18%

PRESSURE AT WHICH WASTE IS INJECTED	
Injection Pressure	Percentage of Wells
Gravity flow	11%
Gravity - 150 psi	19%
151 - 300 psi	15%
301 - 600 psi	6%
601 - 1,500 psi	13%
over 1,500 psi	2%
unknown	34%

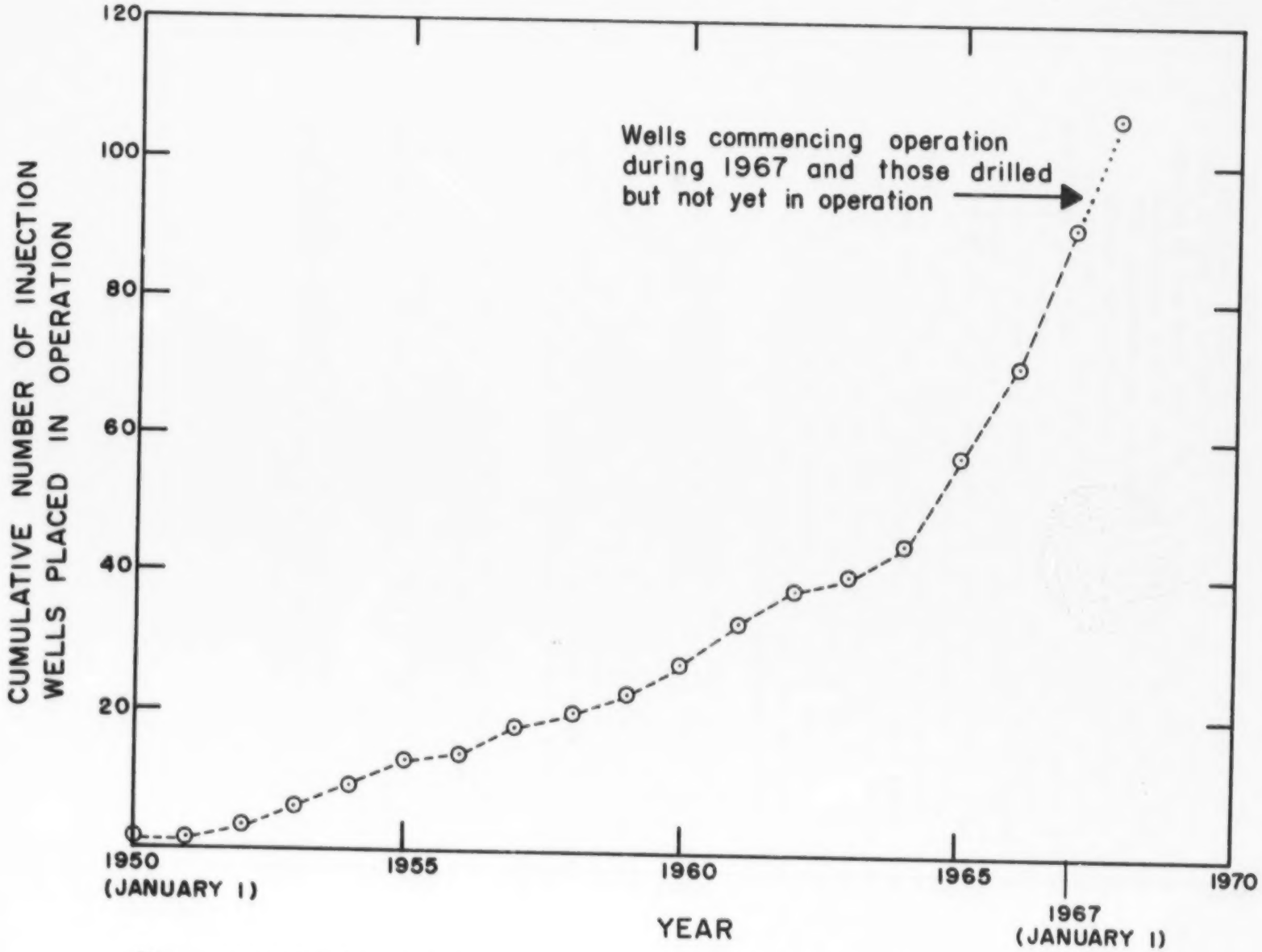

Figure 1. Number of injection wells placed in operation each year during the period January 1950 to January 1967.

Some of the remaining wells are operated by a paper mill, a uranium mill, an airlines maintenance facility, a nylon plant, a coking plant, an aerospace facility, and a photo processing facility. The wells range in total depth from a few hundred to over 12,000 feet, but 64 percent are less than 4,000 feet deep and 92 percent are less than 6,000 feet deep. Injection is into unlithified sands (33%), sandstones (41%), limestones and dolomites (22%) with the exception of five wells. The Rocky Mountain Arsenal well (Cl-1) is injecting into fractured Precambrian gneiss, one of the Hammermill Paper Company wells (P-3) is reportedly injecting into fractured or sheared Precambrian crystalline rocks as well as younger sandstone and carbonate reservoirs, and three wells (Ka-1, Mc-18, and Mc-19) are injecting into evaporite sequences. Available injection rate and pressure data are not considered particularly satisfactory, but they indicate the range within which existing wells are operating. Injection rates for a single well range from a few gallons per minute to over 900 gpm with 34 percent injecting less than 100 gpm and 78 percent injecting less than 400 gpm. Eleven percent of the wells are injecting by gravity flow and 51 percent are injecting at a well-head pressure of less than 600 psi. It is probable that most of the wells for which data are not available are injecting less than 400 gpm at a pressure of less than 600 psi.

Figure 1 shows the number of injection wells placed in operation during each year from January 1950 to January 1967. More wells (46) were put into operation during the three-year period from January 1964 to January 1967, than during the previous 14-year period 1950-1963 (45 wells). This increase in rate of construction of injection wells can be attributed to increased emphasis on water pollution control and the more widespread acceptance of this disposal method that has accompanied its successful use.

The existing injection systems in the United States are heavily concentrated in the north-central and Gulf Coast areas. This distribution is a result of a combination of factors including favorable subsurface geology, heavy industrial concentration, and the attitude of the various states regarding the use of subsurface disposal systems.

The cooperation of the various state agencies, industrial companies, and individuals who have supplied information contained herein is appreciatively acknowledged.

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INJECTION WELL DATA

Ca-1

1. Aerojet General Corporation
2. Sacramento, California
3. January 1963
4. A. 1,564 ft.
   B. 970-1,564 ft.
   C. Sands interbedded with siltstone and mudstone - Tertiary age
5. Waste from nitroplasticizer plant total dissolved solids 48,000 ppm; Na 14,500 ppm; K 6,000 ppm; NO_2 2,100 ppm; SO_4 12,100 ppm; Cl 9,350 ppm; pH 6.2-12.2.
6. Variable - 30 gpm average
7. 50 psi maximum allowable
8. Written communication California State Water Quality Control Board and Aerojet General Corporation

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Ca-2

1. Fairchild Space and Defense Systems Division, Photo Processing Plant
2. Beale Air Force Base, California near Marysville, California
3. 1966
4. A. 1,110 ft. plugged back to 1,071 ft.
   B. 989-1,070 ft.
   C. Wheatland (?) Formation -
      Sand - Eocene (?) age
5. Photo processing waste including developers, fix solutions, hardeners, bleaches, and wash waters from both color and black and white processes. The waste liquid contains dissolved silver that is removed by exchange with iron before injection.
6. ---
7. ---
8. Written communication Fairchild Space and Defense Systems

Ca-3

1. Fairchild Space and Defense Systems Division, Photo Processing Plant
2. Beale Air Force Base, California near Marysville, California
3. 1966
4. A. 1,304 ft. plugged back to 1,196 ft.
   B. 1,106-1,196 ft.
   C. Wheatland (?) Formation - Sand - Eocene (?) age
5. Photo processing waste including developers, fix solutions, hardeners, bleaches, and wash waters from both color and black and white processes. The waste liquid contains dissolved silver that is removed by exchange with iron before injection.

Ca-3 (Continued)

6. ---
7. ---
8. Written communication Fairchild Space and Defense Systems

Ca-4

1. Fairchild Space and Defense Systems Division, Photo Processing Plant
2. Beale Air Force Base, California near Marysville, California
3. 1966
4. A. 1,289 ft. plugged back to 1,213 ft.
   B. 1,104 - 1,203 ft.
   C. Wheatland (?) Formation - Sand - Eocene (?) age
5. Photo processing waste including developers, fix solutions, hardeners, bleaches, and wash waters from both color and black and white processes. The waste liquid contains dissolved silver that is removed by exchange with iron before injection.
6. ---
7. ---
8. Written communication Fairchild Space and Defense Systems

Cl-1

1. U. S. Army Corps of Engineers
2. Rocky Mountain Arsenal, 10 miles northeast of Denver, Colorado
3. March 1962 (operation suspended during February 1966)*
4. A. 12,045 ft.
   B. 11,975-12,045 ft.
   C. Fractured gneiss of Precambrian age
5. Analysis not available described as slightly basic (pH 8) and containing ammonia, nitrates, chlorides, chlorates, chlorinated hydrocarbons, and organic phosphorous compounds.
6. Variable about 200 gpm when operating
7. About 500 psi at an injection rate of 200 gpm. Maximum pressure about 1,000 psi.
8. Polumbus, E. A., and Associates, 1961
   Mechem and Garrett, 1963
   Scopel, 1964
   Donaldson, 1964

*Well operation was suspended because it was suggested that the well may have been associated with earthquakes that have occurred in the Denver area since 1962 (Evans, 1966).

F-1

1. Chemstrand Company, Division of Monsanto Company
2. Pensacola, Florida
3. July 1965
4. A. 1,800 ft.
   B. 1,400-1,600 ft.
   C. Lower limestone of Floridan aquifer - limestone - Tertiary age
5. Variable waste from nylon plant composed of organic monobasic and diabasic acids, nitric acid, ammonia, adiponitrile, hexamethylene-diamine, sodium hydroxide, sodium carbonate, alcohols, and ketones. Turbidity 35-95 ppm, pH 2.2-8.9.
6. 288-1,100 gpm
7. Injection pressure decreased during operation from an initial 288 gpm at 149 psi to 700 gpm at 137 psi during 1964. Decrease in injection pressure is attributed to dissolution of injection horizon by acid waste.
8. Batz, 1964
   Dean, 1965
   Barraclough, 1966

F-2

1. Sugar Cane Growers Cooperative
2. Near Belle Glade, Florida
3. 1966
4. A. ± 1,900 ft.
   B.
   C. Cedar Keys Formation - limestone - Tertiary age
5. 1% acetic acid solution
6. ---
7. ---
8. Written communication Florida Geological Survey

I1-1

1. Velsicol Chemical Corporation
2. Near Marshall-Clark County, Illinois
3. March 1966
4. A. 2,636 ft.
   B. 2,372-2,636 ft.
   C. Limestone of Devonian age
5. The waste is produced from the manufacture of chlordane and contains about 100,000 mg/l dissolved solids, primarily spent sodium hypochlorite and sodium chloride, and 50 ppm suspended solids. The specific gravity is about 1.14 and the pH is about 12.5
6. 60,000 gpd (42 gpm)
7. Gravity flow
8. Written communication Illinois Sanitary Water Board and written and oral communication Velsicol Chemical Corporation

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I1-2

1. Cabot Carbon Corporation
2. Near Tuscola, Douglas County, Illinois
3. 1966
4. A. 5,317 ft.
   B. 4,898 ft.
   C. Eminence Dolomite - Cambrian age
      Potosi Dolomite - Cambrian age
      Franconia Formation - Cambrian age
5. Hydrochloric acid solution
6. 35,000 gpd maximum (25 gpm)
7. Gravity flow
8. Written communication Illinois Sanitary Water Board

I1-3

1. Jones and Laughlin Steel Corporation
2. Near Hennepin, Putnam County, Illinois
3. Not yet in operation March 1967
4. A. 4,868 ft.
   B. 3,144 to 4,868 ft.
   C. Mt. Simon Sandstone - Cambrian age
5. Hydrochloric and chromic acid solution
6. 130 gpm anticipated
7. 200 psi maximum allowable
8. Written communication Illinois Sanitary Water Board

In-1

1. American Cyanamid Company
2. Michigan City, Indiana
3. 1951
4. A. 295 ft.
   B. 200 to 295 ft.
   C. Sandstone
5. Waste from preparation of aluminum oxide petroleum catalytic cracking catalyst. Waste contains 6,500 mg/l sodium sulfate, 5,000 mg/l ammonium sulfate, and 150 mg/l acidity.
6. 350 gpm
7. 50 psi
8. Donaldson, 1964
   Written communication Indiana Stream Pollution Control Board

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In-2

1. American Cyanamid Company
2. Michigan City, Indiana
3. 1951
4. A. 650 ft.
   B. 270 to 650 ft.
   C. Limestone and dolomite of Silurian and Devonian age
5. Waste from preparation of aluminum oxide petroleum catalytic cracking catalyst. Waste contains 6,500 mg/l sodium sulfate, 5,000 mg/l ammonium sulfate, and 150 mg/l acidity.
6. 350 gpm. Used alternately with In-1
7. 50 psi
8. Donaldson, 1964
   Woodley and Moore, 1966
   Written communication Indiana Stream Pollution Control Board

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In-3

1. Indiana Farm Bureau Co-op Association, Inc.
2. Mt. Vernon, Indiana
3. 1959
4. A. 2,400 ft.
   B. 2,000 - 2,200 ft.
   C. Hardinsburg Formation - Sandstone - Mississippian age
5. Waste water containing 0.1 lb/gal. sulfides
6. 6,300 gallons/month
7. ---
8. Woodley and Moore, 1966
   Written communication Indiana Stream Pollution Control Board

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In-4

1. FMC Corporation, Newport Army Ammunition Plant
2. Newport, Indiana
3. November 1960
4. A. 6,160 ft.
   B. 5,450 - 6,160 ft.
   C. Mt. Simon Sandstone - Sandstone - Cambrian age
5. Highly toxic waste from chemical manufacture consisting in part of sodium hydroxide, phosphorous trichloride, methyldichlorophosphine, ethanol, and ammonium chloride. pH greater than 10, suspended solids 0.1 - 0.2 percent.
6. 50 - 110 gpm when operating
7. 400 - 1,200 psi
8. Hundley and Matulis, 1962 and 1963
   Donaldson, 1964
   Woodley and Moore, 1966
   Written communication Indiana Stream Pollution Control Board and oral communication FMC Corporation

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In-5

1. Bethlehem Steel Corporation
2. Chesterton, Indiana
3. 1964
4. A. 4,304 ft.
   B. 2,222 - 4,263 ft.
   C. Eau Claire and Mt. Simon Formations - Sandstones - Cambrian age
5. Steel pickling liquor, 6-10% sulfuric acid and 14-18% ferrous sulfate
6. 150 gpm
7. 700 psi
8. Written communication Indiana Stream Pollution Control Board and Indiana Geological Survey
   Woodley and Moore, 1966

In-6

1. Midwest Steel Division
   National Steel Corporation
2. Portage, Indiana
3. February 1965
4. A. 4,308 ft.
   B. 2,160 - 4,259 ft.
   C. Eau Claire and Mt. Simon - Sandstones - Cambrian age
5. Steel pickling liquor, 6-10% sulfuric acid and 14-18% ferrous sulfate
6. 75 gpm
7. gravity flow
8. Written communication Indiana Stream Pollution Control Board and Indiana Geological Survey
   Woodley and Moore, 1966
   Hartman, 1966

In-7

1. U. S. Steel Corporation
2. Gary, Indiana
3. Well completed 1965 not yet in operation January 1967
4. A. 4,303
   B. 2,452 - 4,303 ft.
   C. Mt. Simon Sandstone - Sandstone - Cambrian age
5. Steel pickling liquor, 8-37% sulfuric acid, 18-25% ferrous sulfate, and 2-6% chromic acid
6. 6,500,000 gal/month (15 gpm on a 30 day basis)
7. ---
8. Written communication, Indiana Stream Pollution Control Board and Indiana Geological Survey
   Woodley and Moore, 1966

In-8

1. General Electric Company
2. Mt. Vernon, Indiana
3. 1966
4. A. 2,806
   B. 2,760 - 2,806 ft.
   C. Bethel Formation - Sandstone - Mississippian age
5. Dilute aqueous waste containing phenol and hydrochloric acid from manufacture of plastic.
6. Approximately 40 gpm
7. Up to 225 psi
8. Oral communication private consultant

In-9

1. Inland Steel Company
2. East Chicago, Indiana
3. 1967
4. A. ± 4,300 ft.
   B. ± 2,300 - 4,300 ft.
   C. Mt. Simon Formation - Sandstone - Cambrian age
5. Steel pickling liquor averaging 8% H_2SO_4 and .75% HCl
6. Anticipated 120 gpm with a maximum of 150 gpm
7. ---
8. Oral communication private consultant

Io-1

1. Quaker Oats Company
2. Cedar Rapids, Iowa
3. 1955 (not in use as of Nov. 1965)
4. A. 2,525 ft.
   B. 2,010 - 2,525 ft.
   C. Mt. Simon Sandstone - Sandstone - Cambrian age
5. 1.5% solution of organic acetic acid
6. ---
7. ---
8. Written communication, Iowa Geological Survey

Ka-1

1. Frontier Chemical Company
2. Wichita, Kansas
3. 1952

Ka-1 (Continued)

4. A. 400 ft.
   B. 240 - 322 ft.
   C. Geuda salt section of the Wellington Formation - Permian age
5. Saturated brines, lime sludge, and waste sodium hydroxide derived from production of chlorine, sodium hydroxide, and related products. Raw material is brine obtained from the Wellington Formation.
6. 100 - 200 gpm with maximum of about 350 gpm
7. Gravity flow
8. Donaldson, 1964
   Written communication, Kansas State Dept. of Health

Ka-2

1. Frontier Chemical Company
2. Wichita, Kansas
3. May 1961 (the original well, completed in 1956, was lost in 1961 when the well casing corroded through and collapsed in the well)
4. A. 4,125 ft.
   B. 3,927 - 4,125 ft. (perforated 3,990 - 4,115 ft.)
   C. Arbuckle Limestone - Limestone - Ordovician age
5. Unsaturated Ca and Mg brine solutions, impure bromine, chlorinated organics, and hydrochloric acid. The pH ranges from 1 to 9 during short periods. The waste is derived from production of chlorine, sodium chloride, and related products from brines in the Wellington Formation.
6. 200 - 400 gpm
7. Gravity flow
8. Donaldson, 1964
   Written communication, Kansas State Board of Health

L-1

1. Universal Oil Products
2. Caddo Parish, Louisiana
   Sec. 29 T19N-R15W
3. 1952
4. A. 2,262 ft.
   B. 987 and 1,998 (formation tops)
   C. Nacatoch and Blossom Sands - Tertiary age
5. Waste water containing sodium, calcium, magnesium, chloride, sulfate, and organic chemicals.
6. 500 gpm into 4 wells (L1-L4)
7. ---
8. Written communication, Louisiana Geological Survey

L-2

1. Universal Oil Products
2. Caddo Parish, Louisiana
   Sec. 29 T19N-R15W
3. 1957
4. A. ±2,100 ft.
   B. About the same as L1
   C. Nacatoch and Blossom Sands - Tertiary age
5. Waste water containing sodium, calcium, magnesium, chloride, sulfate, and organic chemicals.
6. 500 gpm into 4 wells (L1-L4)
7. ---
8. Written communication, Louisiana Geological Survey

L-3

1. Universal Oil Products
2. Caddo Parish, Louisiana
   Sec. 29 T19N-R15W
3. 1961
4. A. 1,102 ft.
   B. 984 ft. (top)
   C. Nacatoch Sand - Tertiary age
5. Waste water containing sodium, calcium, magnesium, chloride, sulfate, and organic chemicals.
6. 500 gpm into 4 wells (L1-L4)
7. ---
8. Written communication, Louisiana Geological Survey

L-4

1. Universal Oil Products
2. Caddo Parish, Louisiana
   Sec. 29 T19N-R15W
3. 1967
4. A. ± 1,100 ft.
   B. ± 975 ft.
   C. Nacatoch Sand - Tertiary age
5. Waste water containing sodium, calcium, magnesium, chloride, sulfate, and organic chemicals.
6. 500 gpm into 4 wells (L1-L4)
7. ---
8. Written communication, Louisiana Geological Survey

L-5

1. Shell Chemical Company, Norco Plant
2. Norco, Louisiana, St. Charles Parish
3. 1956
4. A. 1,960 ft.
   B. 1,670 - 1,960 ft.
   C. Unconsolidated sand reported to be of Pleistocene age
5. Originally waste water containing calcium and sodium chlorides, dissolved organics, and suspended silica and calcium carbonate particles, with small amounts of chlorinated organics was injected intermittently. Most recently reported to be injecting waste water containing acrolein and derivatives of acrolein, toxic organic chemicals, diatomaceous earth, and aluminum hydroxide.
6. Up to 600 gpm before construction of L-6
7. 210 psi at 600 gpm
8. Moffett, 1960
   Donaldson, 1964
   Hough, 1963
   Hough, 1965

L-6

1. Shell Chemical Company, Norco Plant
2. Norco, Louisiana, L-5 and L-6 are only 30 ft. apart at the surface and 300 ft. apart at the bottom
3. 1959
4. A. ± 1,800 ft.
   B. 1,670 - 1,800 ft.
   C. Unconsolidated sand reported to be of Pleistocene age
5. Waste water containing acrolein and derivatives of acrolein, toxic organic chemicals, diatomaceous earth, and aluminum hydroxide.
6. 700 gpm into 2 wells (L-1 and L-2)
7. 150 - 170 psi
8. Moffett, 1960
   Donaldson, 1964
   Hough, 1963
   Hough, 1965

L-7

1. Shell Chemical Company, Norco Plant
2. Norco, Louisiana
3. 1966
4. A. 2,100 ft.
   B. 1,700 ft. (top)
   C. Sand - probably of Pliocene age
5. Similar to L-6
6. ---
7. ---
8. Written communication Louisiana Geological Survey

L-8

1. Shell Chemical Company, Norco Plant
2. Norco, Louisiana
   Sec. 4 T12S-R8E
3. Not yet in operation
4. A. 2,000 ft.
   B. Not available
   C. Sand - probably of Pliocene age
5. 30% HCl solution
6. Estimated to be about 30 gpm
7. ---
8. Written communication, Louisiana Geological Survey

L-9

1. Shell Oil Company, Norco Refinery
2. Norco, Louisiana
3. 1959
4. A. 1,795 ft.
   B. 1,700 - 1,900 ft.
   C. Unconsolidated sand reported to be of Pleistocene age
5. Refinery process water with 1,790 ppm sulfides, 165 ppm phenols, 38 ppm mercaptans, and 20 ppm suspended solids
6. 200 gpm
7. 30-90 psi
8. Graves, 1961
   Donaldson, 1964
   Hough, 1963, 1965

L-10

1. Shell Oil Company
2. Norco, Louisiana
   Sec. 6 T12S-R8E
3. 1965
4. A. 1,954 ft.
   B. 1,848 ft. (top)
   C. Sand - probably of Pliocene age
5. Waste water containing sulfides, phenol, oil, and suspended solids
6. 187 gpm average
7. ---
8. Written communication, Louisiana Geological Survey

L-11

1. Shell Oil Company
2. Norco, Louisiana
   Sec. 6 T12S-R8E
3. 1965
4. A. 1,997 ft.
   B. 1,858 ft. (top)
   C. Sand - probably of Pliocene age
5. Waste water containing sulfides, phenol, oil, and suspended solids
6. 110 gpm average
7. ---
8. Written communication, Louisiana Geological Survey

L-12

1. Shell Chemical Company, Geismar Chemical Plant
2. Geismar, Louisiana, Ascension Parish
   Sec. 14 T10S-R2E
3. 1966
4. A. 1,980 ft.
   B. 1,970 - 1,975 ft.
   C. Sand of Tertiary (Pliocene or Miocene) age
5. 50 gpm of hydrochloric acid solution from plant operations
6. ---
7. ---
8. Hough, 1965
   Written communication, Louisiana Geological Survey

L-13

1. Shell Chemical Company, Geismar Chemical Plant
2. Geismar, Louisiana
   Sec. 14 T10S-R2E
3. 1967
4. A. 2,506 ft.
   B. 1,550 ft.
   C. Sand - probably of Pliocene age
5. Waste water
6. ---
7. ---
8. Written communication, Louisiana Geological Survey

L-14

1. Tenneco Oil Company, Chalmette Refinery
2. Chalmette, Louisiana, St. Bernard Parish
   Sec. 7 T13S-R12E
3. 1960
4. A. 1,980 ft.
   B. 1,944 - 1,968 ft.
   C. Unconsolidated sand reported to be of Pleistocene age
5. Waste from catalytic cracker containing phenols, mercaptans, and sulfides, and brine from crude-oil desalting unit.
6. 100 gpm
7. 40-100 psi
8. Donaldson, 1964
   Hough, 1965

L-15

1. Tenneco Oil Company, Chalmette Refinery
2. Chalmette, Louisiana, St. Bernard Parish
   Sec. 7 T13S-R12E
3. 1963
4. A. 2,000 ft.
   B. 1,920 - 1,950 ft.
   C. Sand of Pleistocene or Pliocene age
5. 7 gpm of waste water from petroleum refining processes containing traces of phenol, hydrocarbons, and sulfides, pH 7.4.
6. 7 gpm (?)
7. ---
8. Hough, 1965
   Written communication, Louisiana Geological Survey

L-16

1. National Aeronautics and Space Administration
2. New Orleans, Louisiana, Orleans Parish
3. 1964
4. A. About 7,000 ft.
   B. About 6,000 ft.
   C. Sand of Tertiary (Miocene) age
5. Waste cleaning solutions and rinse water including acids, alkalis, and chromates from cleaning of rocket components.
6. 400,000 gpd (278 gpm)
7. 1,350 psi maximum
8. Chemical Week, 1965
   Hough, 1965

L-17

1. Texaco, Inc., Louisiana Plant (refinery)
2. Convent, Louisiana, St. James Parish
   Sec. 12 T11S-R3E
3. 1966
4. A. 2,201 ft.
   B. 1,840 ft.
   C. Sand of Tertiary (Pliocene or Miocene) age
5. 600 to 800 gpm of salt water from crude oil desalting and waste water from petroleum refining operations. Waste contains about 600 ppm dissolved solids, 70 ppm phenols, sulfides, and 10 ppm suspended solids and has a pH of 6-8.
6. 600 to 800 gpm into two wells
7. ---
8. Hough, 1965
   Written communications, Louisiana Geological Survey and project consultant.

L-18

1. Texaco, Inc., Louisiana Plant
2. Convent, Louisiana, St. James Parish
3. 1966
4. A. 2,195 ft.
   B. 2,103 - 2,193 ft.
   C. Sand of Tertiary (Pliocene or Miocene) age
5. 600 to 800 gpm of salt water from crude oil desalting and waste water from petroleum refining operations. Waste contains about 6,000 ppm dissolved solids, 70 ppm phenols, sulfides, and 10 ppm suspended solids and has a pH of 6-8.
6. 600-800 gpm into two wells
7. ---
8. Hough, 1965
   Written communications, Louisiana Geological Survey and project consultant.

L-19

1. American Cyanamid Company (chemical plant)
2. Avondale, Louisiana, Jefferson Parish
3. March 1966
4. A. 2,721 ft.
   B. 2,465 - 2,495 ft.
   C. Sand of Tertiary (Pliocene) age
5. 20 gpm waste water containing cyanides, sulfates, ammonia, and nitriles
6. 225 gpm into L-20 and L-21
7. ---
8. Hough, 1965
   Written communication, Louisiana Geological Survey

L-20

1. American Cyanamid Company
2. Avondale, Louisiana, Jefferson Parish
3. March 1966
4. A. 3,302 ft.
   B. 3,145 - 3,200 ft.
   C. Sand of Tertiary (Pliocene) age
5. 20 gpm waste water containing cyanides, sulfates, ammonia, and nitriles
6. 225 gpm into L-20 and L-21
7. ---
8. Hough, 1965
   Written communication, Louisiana Geological Survey

L-21

1. E. I. DuPont de Nemours and Company
2. Ponchatrain, Louisiana, St. John The Baptist Parish
   Sec. 90 T11S-R7E
3. 1966
4. A. 5,203 ft.
   B. 5,080 - 5,162 ft.
   C. Sand of Tertiary age
5. Brine solution
6. 30,000 pounds/hr. (about 60 gpm)
7. 130 psi
8. Oral communication, Louisiana Division of Oil and Gas

L-22

1. E. I. DuPont de Nemours and Company
2. Ponchatrain, Louisiana, St. John The Baptist Parish
   Sec. 90 T11S-R7E
3. 1966
4. A. ± 5,200 ft.
   B. ± 5,050 - 5,090 ft.
   C. Sand of Tertiary age
5. Brine solution
6. 140,000 pounds/hr. (about 280 gpm)
7. 225 psi
8. Oral communication, Louisiana Division of Oil and Gas

L-23

1. E. I. DuPont de Nemours and Company
2. Ponchatrain, Louisiana, St. John The Baptist Parish
   Sec. 90 T11S-R7E
3. Not yet in operation as of August 1967
4. A. 5,300 ft.
   B. 4,633 - 4,668 ft. and 5,080 - 5,090 ft.
   C. Sands of Miocene age
5. Brine solution
6. 200 gpm
7. ---
8. Written communication, Louisiana Geological Survey

L-24

1. Perkins Glue Company
2. Alexandria, Louisiana
   Sec. 41 T3N-R1W
3. Not yet in operation as of August 1967
4. A. ± 3,000 ft.
   B. ± 3,000 ft.
   C. Cockfield Formation - Sand - Tertiary age
5. Caustic soda and phenol
6. ---
7. ---
8. Written communication, Louisiana Geological Survey

Mc-1

1. Old Dutch Refining Company
2. Muskegon, Michigan
   Sec. 26 T10N-R16W
3. September 1948
4. A. 2,346 ft.
   B. 1,758 ft.
   C. Dundee Formation and Detroit River Group - Limestone and Dolomite - Devonian age
5. Oil refinery effluent
6. 60-65 gpm est.
7. None recorded
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Note: Well was plugged and abandoned April 12, 1951. No reasons were given.

Mc-2

1. Parke, Davis and Company
2. Holland, Michigan
   Sec. 20 T5N-R15W
3. May 1951
4. A. 1,635 ft.
   B. 1,424 ft.
   C. Traverse Group - Limestone and Dolomite - Devonian age
5. Sodium, acetate, chloride, ammonia, bromide, and unidentified organic compounds. Total dissolved solids 60,000 ppm; pH 3.7; intense reddish-brown color. Waste derived from manufacture of chloromycetin.
6. 1,252,056 gal. per month during 1966 pumped to two wells (about 30 gpm on a 30-day basis)
7. 200-400 psi, average about 280 psi
8. Adinoff, 1955
   Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Note: This well is connected in series with another well (Mc-3). Waste fluids are pumped simultaneously to both wells. Records of quantities and pressures are for this combined system and not each well individually.

Mc-3

1. Parke, Davis and Company
2. Holland, Michigan
   Sec. 20 T5N-R15W
3. October 1956
4. A. 1,946 ft.
   B. 1,649 ft.
   C. Detroit River Group - Dolomite and Limestone - Devonian age
5. Pharmaceutical process wastes
6. 1,252,056 gal. per month during 1966 pumped to two wells (about 30 gpm on a 30-day basis)
7. 200-400 psi, average about 280 psi
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Note: This well was reported injecting in Traverse Group and Dundee Formation; however, there is no record of this. Records indicate the long string of casing was set at 1,649 feet. If the upper zones are open, the Company must have perforated them at a later date.

Mc-4

1. Hooker Electrochemical Company
2. Montague, Michigan
   Sec. 30 T12N-R17W
3. April 1953
4. A. 2,066 ft.
   B. 1,703 ft.
   C. Traverse Group - Limestone - Devonian age
5. Sodium sulphate, sodium chloride, and calcium sulfate
6. No record
7. No record
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Note: Reported November 1965 that their wells (Mc-4 and Mc-5) had plugged with calcium sulfate. They may have reworked one or both of these wells but the records do not indicate this.

Mc-5

1. Hooker Electrochemical Company
2. Montague, Michigan
   Sec. 31 T12N-R17W
3. May 1956
4. A. 2,083 ft.
   B. 1,962-72 & 1,996-2,068 ft.
   C. Traverse Group - Limestone - Devonian age
5. Sodium sulfate, sodium chloride, and calcium sulfate
6. No record
7. No record
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

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Mc-6

1. Reichhold Chemicals, Inc.
2. Ferndale, Michigan
   Sec. 27 T1N-R11E
3. 1952 or 1953
4. A. 1,053 ft.
   B. 693 ft.
   C. Sylvania Formation - Dolomite and Sandstone - Devonian age
5. Phenols
6. 3-1/2 gpm when in operation
7. 35 psi or less when in operation
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Mc-6 (Continued)

Note: Well accepted 1,764 gpm at 125 psi during testing. This well was plugged and abandoned in November 1957 with no reason given.

Mc-7

1. The Upjohn Company
2. Kalamazoo, Michigan
3. May 1954
4. A. 1,530 ft.
   B. 1,270 - 1,530 ft.
   C. Traverse, Dundee, and Detroit River Groups - Sandy Limestone, sandstone, and dolomite - Devonian age
5. Spent mineral acids and their salts, alcohols, chlorinated and unchlorinated hydrocarbons, organic acids, aldehydes, ketones, and steroids. Total dissolved solids 500-7,000 ppm; pH 2.0-8.0, but reported to be constantly at 4.0-4.5 as of 1962. Waste derived from manufacture of cortical steroid products.
6. 50-100 gpm injected into two wells (Mc-7 and Mc-8)
7. 500-990 psi
8. Paradiso, 1956
   Donaldson, 1964
   Written communication, Michigan Water Resources Commission

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Mc-8

1. The Upjohn Company
2. Kalamazoo, Michigan
3. May 1954
4. A. 1,475 ft.
   B. 1,276 - 1,475 ft.
   C. Traverse, Dundee, and Detroit River Groups - Sandy limestone, Sandstone, and Dolomite - Devonian age
5. Spent mineral acids and their salts, alcohols, chlorinated and unchlorinated hydrocarbons, organic acids, aldehydes, ketones, and steroids. Total dissolved solids 500-7,000 ppm; pH 2.0-8.0, but reported to be constantly at 4.0-4.5 as of 1962. Waste derived from manufacture of cortical steroid products.
6. 50-100 gpm injected into two wells (Mc-7 and Mc-8)
7. 500-990 psi
8. Paradiso, 1956
   Donaldson, 1964
   Written communication, Michigan Water Resources Commission

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Mc-9

1. Dow Chemical Company, Bay Refining Company Division
2. Bay City, Michigan
3. 1954
4. A. 4,710 ft.
   B. 4,026 ft.
   C. Lower Detroit River Group - Sandy limestone and Sandstone - Devonian age
5. Waste water containing phenol, acid, and spent caustic.
6. About 45 gpm
7. 1,200 psi and greater
8. Written communication, Michigan Water Resources Commission

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Mc-10

1. Dow Chemical Company, Bay Refining Company Division
2. Bay City, Michigan
3. September 1959
4. A. 4,605 ft.
   B. 4,497 ft.
   C. Sylvania Formation - Sandstone - Devonian age
5. Waste water containing phenol, acid, and spent caustic.
6. About 45 gpm when operating
7. Estimated to be 1,200 psi when operating
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

Note: Well Mc-10 is being used as a standby for well Mc-9.

Mc-11

1. Dow Chemical Company
2. Midland, Michigan
3. April 1960 (drilled May 1952)
4. A. 3,740 ft.
   B. 3,580 ft.
   C. Dundee Formation - Limestone - Devonian age
5. Organic wastes similar to phenol, brine, propylene oxide, methyl cellulose, and wash water containing small amounts of organic chemicals. Wastes are from oil refining and salt-mining operations.
6. No record
7. No record
8. Written communication, Michigan Water Resources Commission Donaldson, 1964

Note: This well is being used as a standby for wells Mc-12 and Mc-13.

Mc-12

1. Dow Chemical Company
2. Midland, Michigan
3. July 1960 (drilled 1945)
4. A. ---
   B. 3,865 ft.
   C. Dundee Formation - Limestone - Devonian age
5. Organic wastes similar to phenol, brine, propylene oxide, methyl cellulose, and wash water containing small amounts of organic chemicals. Wastes are from oil refining and salt mining operations.
6. Approximately 200 gpm
7. 140 - 585 psi
8. Written communication, Michigan Water Resources Commission Donaldson, 1964

Mc-13

1. Dow Chemical Company
2. Midland, Michigan
3. July 1961 (drilled 1951)
4. A. 5,150 ft.
   B. 4,925 ft.
   C. Sylvania Formation - Sandstone - Devonian age
5. Organic wastes similar to phenol, brine, propylene oxide, methyl cellulose, and wash water containing small amounts of organic chemicals. Wastes are from oil refining and salt mining operations.
6. Approximately 200 gpm
7. 350 - 965 psi
8. Written communication, Michigan Water Resources Commission Donaldson, 1964

Mc-14

1. Dow Chemical Company
2. Midland, Michigan
3. June 1964
4. A. 3,930 ft.
   B. 3,915 ft.
   C. Dundee Formation - Limestone - Devonian age
5. Activated sludge produced as a by-product of waste treatment (3% organic solids).
6. Approximately 60 gpm
7. 1,725 - 2,850 psi
8. Written communication, Michigan Water Resources Commission

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Mc-15

1. Ford Motor Company
2. Dearborn, Michigan
3. 1956
4. A. 563 ft.
   B. 482 ft.
   C. Sylvania Formation - Sandstone - Devonian age
5. Phenols and coke quench water from coke manufacture
6. Approximately 50,000 gpd (35 gpm)
7. 54 - 663 psi
8. Donaldson, 1964
   Written communication, Michigan Water Resources Commission

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Mc-16

1. Leonard Refineries, Inc.
2. Alma, Michigan
3. June 1957
4. A. 1,244 ft.
   B. 1,030 ft.
   C. Marshall Formation - Sandstone - Mississippian age
5. Foul condensate and spent caustic solution from refinery operations.
6. 25-30 gpm
7. 550 - 940 psi
8. Written communication, Michigan Water Resources Commission

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Mc-17

1. Holland-Suco Color Company, subsidiary of Chemetron Corporation
2. Holland, Michigan
3. 1966
4. A. 5,895 ft.
   B. 4,608 - 5,895 ft.
   C. Franconia, Dresbach, Eau Claire, and Mt. Simon Formations - Sandstones - Cambrian age
5. Contaminated dilute sulfuric acid from pigment manufacturing
6. 25 gpm average - up to 120 gpm
7. 125 psi average - up to 275 psi
8. Winar, 1966
   Civil Engineering, 1966
   Written communication, Michigan Water Resources Commission

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Mc-18

1. Wyandotte Chemicals Corporation
2. Wyandotte, Michigan
3. October 1966
4. A. 1,400 ft. estimated
   B. 850 ft.
   C. Salina Group - Evaporites - Silurian age
5. Process wastes containing 3% solids
6. 375 - 1,075 gpm into two wells
7. Gravity
8. Written communication, Michigan Water Resources Commission

Note: This well is connected in series with another well (Mc-19). Waste fluids are pumped simultaneously to both wells. Records of quantities are for this combined system and not each well individually. Wastes are injected into salt solution cavities.

Mc-19

1. Wyandotte Chemicals Corporation
2. Wyandotte, Michigan
   Sec. 23 T12N-R2W
3. October 1966
4. A. 1,400 ft. est.
   B. 850 ft.
   C. Salina Group - Evaporites - Silurian age
5. Process wastes containing 3% solids
6. 375 - 1,075 gpm into two wells
7. Gravity
8. Written communication, Michigan Water Resources Commission

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Mc-20

1. Blunk Laundromat
2. Union Lake, Michigan
   Sec. 35 T3N-R8E
3. March 1967
4. A. 1,840 ft.
   B. 1,774 ft.
   C. Sylvania Formation - Sandstone - Devonian age
5. Laundromat wastes
6. Estimated 5-1/2 gpm
7. Gravity
8. Written communication, Michigan Water Resources Commission

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Mc-21

1. Michigan Chemical Corporation
2. St. Louis, Michigan
3. May 1967
4. A. 3,762 ft.
   B. 3,422 ft.
   C. Dundee Formation - Dolomite and Limestone - Devonian age
5. Waste brines from processing of natural brine.
6. 200 gpm
7. Gravity
8. Written communication, Michigan Water Resources Commission and Michigan Geological Survey

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Nm-1

1. The Anaconda Company
2. Grants, New Mexico
3. December 1960
4. A. 2,511 ft.
   B. 950 - 1,450 ft. (approximately)
   C. Yeso Formation - Sandstone - Permian age
5. Mildly acid solution containing large amounts of manganese, iron and sulfate and chloride salts of sodium, calcium, and magnesium. Also contains small concentrations of uranium, Thorium-230, and Radium-226. Total dissolved solids 16,243 ppm; pH2.8; waste from uranium ore processing.
6. 200 - 300 gpm
7. Gravity flow
8. Arlin, 1962
   Donaldson, 1964
   Written communication, New Mexico Department of Public Health (inquiries may be directed to New Mexico Department of Public Health)

Oh-1

1. Armco Steel Corporation
2. Middletown, Ohio
3. Probably will not be put in operation until late 1968.
4. A. 3,297 ft.
   B. 2,922 - 3,235 ft.
   C. Mt. Simon Formation - Sandstone - Cambrian age
5. Steel pickling liquor maximum concentrations of 1% HCl, 25% $FeCl_2$, and 1-1/2% $FeCl_3$.
6. Estimated 100 gpm
7. Estimated 450 psi
8. Oral communication, Armco Steel and project consultants

Ok-1

1. American Airlines, Inc.
2. Tulsa, Oklahoma
3. January 1960
4. A. 3,036 ft.
   B. 1,807 - 3,036 ft.
   C. Arbuckle - Limestone - Ordovician age
5. Complex mixture of rinse water and batch dumpings from electroplating tanks, various organic solvents, cresols and phenols, detergents, paint removers, and oil. pH range 5.6-9.4. Waste from maintenance of aircraft.
6. 196,000 gpd during an 11 hour period (300 gpm while operating)
7. 300 psi
8. Luff, 1960
   Donaldson, 1964
   Written communication, Oklahoma State Department of Health

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P-1

1. Jones and Laughlin Steel Corporation
2. Aliquippa, Pennsylvania
3. October 1964
4. A. 5,445 ft.
   B. 5,387 - 5,445 ft.
   C. Oriskany Formation - Sandstone - Devonian age
5. Sulfuric acid waste from steel pickling operations (10% H_2SO_4 and 10% $FeSO_4$)
6. 100 gpm
7. About 4,000 psi
8. Jukkola and Vajada, 1965
   Written communication, Pennsylvania Department of Health

P-2

1. Hammermill Paper Company
2. Erie, Pennsylvania
3. April 1964
4. A. 2,302 ft.
   B. 1,610 - 1,688 ft.
   C. Bass Islands Dolomite - Dolomite - Silurian age
5. Spent sulfite pulping liquor containing fibers, fiber fragments, paper filter materials such as clay and TiO_2, and lignin-like compounds in the colloidal and semi-colloidal particle-size range.
6. 500,000 to 600,000 gpd into two wells (350 to 415 gpm) as of 1967
7. 1,100 - 1,300 psi

P-2 (Continued)

8. Spalding and Others, 1965
   Brown and Spalding, 1966
   Water Well Journal, 1965
   Written communication, Pennsylvania Department of Health

P-3

1. Hammermill Paper Company
2. Erie, Pennsylvania
3. 1965
4. A. 5,972 ft.
   B. 1,658 - 1,732 ft. and 5,914 - 5,952 ft.
   C. Bass Islands Dolomite - Dolomite - Silurian age; Mt. Simon Formation - Sandstone - Cambrian age; sheared or fractured Precambrian basement rocks.
5. Spent sulfite pulping liquor containing fibers, fiber fragments, paper filler materials such as clay and TiO_2, and lignin-like compounds in the colloidal and semi-colloidal particle-size range.
6. 500,000 to 600,000 gpd into two wells (350-415 gpm) as of 1967
7. ---
8. Spalding and Others, 1965
   Brown and Spalding, 1966
   Water Well Journal, 1965
   Written communication, Pennsylvania Department of Health

P-4

1. Gulf Research and Development Company
2. Colerain Township, Bedford County, Pennsylvania
   6 miles south of Bedford, Pennsylvania
3. November 1964
4. A. 563 ft.
   B. 540 - 563 ft.
   C. Bellefonte Dolomite - Dolomite - Ordovician age
5. Drilling mud produced for field experiments with oil-well drilling muds.
6. Used only periodically, 0 - 22,000 gpd
7. 1,000 - 1,300 psi
8. Written communication, Pennsylvania Department of Health

P-5

1. Bethlehem Steel Company
2. Franklin Boro, Cambria County, Pennsylvania
   northeast of Johnston, Pennsylvania
3. Reports indicate that this well was abandoned after initial injection testing in 1966.

P-5 (Continued)

4. A. ---
   B. 570 - 835 ft.
   C. Burgoon Sandstone (Pocono Formation) - Sandstone - Mississippian age
5. Weak ammonia liquor
6. ---
7. ---
8. Written communication, Pennsylvania Department of Health

Tn-1

1. E. I. DuPont de Nemours and Company Pigments Department
2. New Johnsonville, Tennessee
3. 1967
4. A. 6,734 ft.
   B. 3,010 - 6,734 ft.
   C. Knox Dolomite - Cambrian age
5. 13 - 15% aqueous ferric chloride solution. Specific gravity 1.1 pH 1.5-1.6.
6. 300 gpm anticipated
7. 250 psi anticipated
8. E. I. DuPont de Nemours and Company

Tx-1 and Tx-2*

1. Monsanto Chemical Company
2. Chocolate Bayou (10 miles south of Alvin, Texas)
3. 1961
4. A. 6,330 ft.
   B. 6,045 - 6,294 ft.
   C. Unconsolidated sands of Miocene age
5.

Phenol	1,000 - 2,000 mg/l
Oil	150 mg/l
Chlorides	300 mg/l
Sulfates	1,800 mg/l
Total alkalinity (as $CaCO_3$)	2,000 mg/l
COD	10,000 mg/l
pH	10.7

   High-level waste from manufacture of ethylene, propylene, benzene, napthalene, butadiene, phenol, acrylonitrile, soft detergent bases, resins, and other related aromatics.
6. 300 gpm
7. 1,000 psi

*Second well drilled as a source of brine to mix with waste. Could be converted to an injection well.

Tx-1 and Tx-2 (Continued)

8. Sado, 1963, 1966
   Written communication, Texas Water Development Board

Tx-3

1. Potash Company of America
2. 5 miles north of Dumas, Moore County, Texas
3. 1962
4. A. 1,265 ft.
   B. 1,131 - 1,231 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. 31% waste hydrochloric acid from conversion of potassium chloride to potassium sulfate
6. Injection is intermittent with an anticipated maximum of 20,000 gpd (14 gpm)
7. Gravity injection
8. Donaldson, 1964
   Written communication, Texas Water Development Board

Tx-4

1. Shamrock Oil and Gas Corporation, McKee Plant
2. Near Dumas, Moore County, Texas
3. 1958
4. A. ± 1,350 ft.
   B. 1,300 - 1,350 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. Entire waste stream from petroleum refining operation including spent sulfuric acid from alkylation unit, spent caustic and brines from caustic scrubbers, cooling-tower blowdown water, etc.
6. 400 gpm (into two wells)
7. Up to 70 psi
8. Written communication, Texas Water Development Board
   Donaldson, 1964

Tx-5

1. Shamrock Oil and Gas Corporation, McKee Plant
2. Near Dumas, Moore County, Texas
3. 1958
4. A. ± 1,250 ft.
   B. 1,106 - 1,146 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. Entire waste stream from petroleum refining operations including spent sulfuric acid from alkylation unit, spent caustic and brines from caustic scrubbers, cooling-tower blowdown water, etc.

Tx-5 (Continued)

6. 400 gpm (into two wells)
7. Up to 70 psi
8. Written communication, Texas Water Development Board
   Donaldson, 1964

Tx-6

1. Shamrock Oil and Gas Corporation, Sunray Plant
2. Near Dumas, Moore County, Texas
3. ---
4. A. ± 1,250 ft.
   B. 1,138 - 1,158 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. Gasoline plant waste including cooling-tower blowdown water and stripping stream condensate which contains varying amounts of chromates, sulfates, sulfides, and oil.
6. 50-70 gpm
7. 55-100 psi
8. Written communication, Texas Water Development Board
   Donaldson, 1964

Tx-7

1. E. I. DuPont de Nemours and Company, Victoria Plant
2. 4 miles northwest of Bloomington, Victoria County, Texas
3. 1953
4. A. 4,877 ft.
   B. 4,000 - 4,680 ft.
   C. Lower Catahoula and Greta sands - Tertiary age - with upper Catahoula and Oakville sands for possible future use.
5. 18% sodium chloride with traces of metallic salts and organic compounds. Waste derived from manufacture of adiponitrile - an intermediate for nylon.
6. 100-200 gpm (wells Tx-7 and Tx-8 used alternately)
7. 50-200 psi
8. Henkel, 1953, 1955
   Written communication, Texas Water Development Board

Tx-8

1. E. I. DuPont de Nemours and Company
2. 4 miles northwest of Bloomington, Victoria County, Texas
3. 1954
4. A. 4,705 ft.
   B. 4,000 - 4,630 ft.
   C. Lower Catahoula and Greta sands - Tertiary age - with upper Catahoula and Oakville sands for possible future use.

Tx-8 (Continued)

5. 18% sodium chloride with traces of metallic salts and organic compounds. Waste derived from manufacture of adiponitrile - an intermediate for nylon.
6. 100-200 gpm (wells Tx-7 and Tx-8 used alternately)
7. 50-200 psi
8. Henkel, 1953, 1955
   Written communication, Texas Water Development Board

Tx-9

1. E. I. DuPont de Nemours and Company, Victoria Plant
2. 4 miles northwest of Bloomington, Victoria County, Texas

Tx-9 is located midway between Tx-7 and Tx-8 and is generally similar to these wells.

Tx-10

1. E. I. DuPont de Nemours and Company, Victoria Plant
2. 4 miles northwest of Bloomington, Victoria County, Texas
3. December 1963

Tx-10 is located near Tx-8 and is generally similar to Tx-7, Tx-8, and Tx-9.

6. 120 gpm average
7. 200 psi average
8. Written communication, Texas Water Development Board

Tx-11

1. Northern Natural Gas Company
2. 8 miles SE of Spearman, Ochiltree County, Texas
3. January 1964
4. A. 4,057 ft.
   B. 3,722 - 4,016 ft.
   C. Brown Dolomite
5. Waste from natural gas compressor and purification plant

Chloride (as Cl_2)	3,040 ppm
Total Hardness (as $CaCO_3$)	1,089 ppm
Total dissolved solids	12,804 ppm
pH	7.9

6. 4-7 gpm
7. Gravity flow
8. Written communication, Texas Water Development Board

Tx-12

1. Pan American Petroleum Corporation, West Yantis Plant (gas)
2. 4-1/2 miles northwest of Yantis, Wood County, Texas
3. 1963
4. A. 5,231 ft.
   B. 4,775 - 5,160 ft.
   C. Woodbine Group - Sandstone - Cretaceous age
5. Cooling-tower blowdown water, plant process waste water, produced brine separated from natural gas.
6. 2-160 gpm, average 100 gpm
7. Gravity to 390 psi, average 145 psi
8. Written communication, Texas Water Development Board

Tx-13

1. Western Ammonia Corporation
2. 2 miles southeast of Dimmitt, Castro County, Texas
3. August 1964
4. A. 1,048 ft.
   B. 951 - 980 ft.
   C. Santa Rosa Sandstone - Sandstone - Triassic age
5. Cooling-tower blowdown and water treating plant waste from production of anhydrous ammonia.

Total dissolved solids	2,300 - 2,700 ppm
Chloride	40 - 60 ppm
Sulfate	800 - 1,500 ppm
Sodium	280 - 400 ppm
Nitrogen (as ammonia)	20 - 46 ppm
Chromium	10 - 20 ppm
pH	3.0

6. 30 - 50 gpm
7. Initially gravity injection, as of April 1965 average injection pressure about 270 psi.
8. Written communication, Texas Water Development Board

Tx-14

1. Celanese Chemical Company
2. 7.5 miles southwest of Bay City, Matagorda County, Texas
3. 1964
4. A. 3,780 ft.
   B. 3,507 - 3,552 ft.
   C. Sand of Tertiary (Miocene) age
5. 0.3% acetic acid and chlorinated derivatives from production of acetaldehyde, butanol, and other organic acids by catalytic cracking of natural gas.
6. 200 gpm
7. 200 psi
8. Written communication, Texas Water Development Board
   Klotzman and Vier, 1966

Tx-15

1. Atlantic Refining Company, ATRECO Refinery
2. 6 miles northeast of Port Arthur, Jefferson County, Texas
3. December 1964 (not in use as of January 1967)
4. A. 3,412 ft.
   B. 2,758 - 2,834 ft.
   C. Sands of Miocene age
5. 32% hydrochloric acid solution containing benzene, chlorinated hydrocarbons, etc. Waste generated during production of detergents. Total waste production estimated to initially be 35,000 gpd increasing to a maximum of 53,000 gpd and remaining at this level.
6. Injection rate about 35 gpm in December 1964
7. Gravity flow
8. Written communication, Texas Water Development Board

Tx-16

1. Pan American Petroleum Corporation, Edgewood Gas Processing Plant
2. 3 miles east of Edgewood, Van Zandt County, Texas
3. 1964
4. A. 4,862 ft.
   B. 4,652 - 4,828 ft.
   C. Woodbine Group - Sandstone - Cretaceous age
5. Cooling-tower and boiler blowdown water, process waste water and produced salt water separated from natural gas.
6. 25 - 205 gpm, average 130 gpm
7. 50 - 300 psi during 1965 and 1966
8. Written communication, Texas Water Development Board

Tx-17 and Tx-18

1. Service Pipe Line Company
2. 6 miles southeast of Sundown, Hockley County, Texas
3. 1964
4. A. ± 2,150 ft.
   B. 1,700 - 2,150 ft.
   C. Santa Rosa Sandstone - Sandstone - Triassic age
5. Saturated brine created during "washing-out" of a cavity in the salt interval of the Salado Formation for underground liquid-petroleum-gas storage. Wells will only be used actively during washing out period, then will be used for emergencies or during creation of new activities.
6. Up to 680 gpm for two wells
7. Up to 735 psi
8. Written communication, Texas Water Development Board

Tx-19

1. E. I. DuPont de Nemours and Company, Sabine River Works
2. 2 miles south-southeast of West Orange, Orange County, Texas
3. 1965 (presently a standby well replaced in 1966 by Tx-32)
4. A. 5,252 ft.
   B. 2,240 - 2,920 ft.
   C. Sands of Pliocene - Miocene age
5. Waste water containing 0.7% nitric acid and 1.0% straight chain organic acids. Waste from production of polyethylene and related products.
6. 375 gpm
7. 350 psi
8. Written communication, Texas Water Development Board

Tx-20

1. Monsanto Company
2. Near Alvin, Brazoria County, Texas
3. May 1965
4. A. 12,750 ft. (abandoned oil test completed as a waste injection well)
   B. 6,256 - 6,936 ft.
   C. Tertiary (Miocene) sands
5. Highly mineralized waste water from petrochemical manufacture containing significant amounts of organic nitrogen, nitriles, and other soluble organic chemicals. Weak radioactive waste added in 1966.
6. 600 gpm
7. 450 psi
8. Oral communication, Texas Water Development Board

Tx-21

1. Celanese Chemical Company, Bay City Plant
2. 7.5 miles southwest of Bay City, Matagorda County, Texas (see Tx-14)
3. March 1965
4. A. 3,750
   B. 3,520 - 3,550 ft.
   C. Sands of Tertiary (Miocene) age
5. Up to 200 gpm of liquid waste containing organic and inorganic chemicals. Waste derived from manufacture of acetaldehyde, adipic acid, butanol and other petrochemicals.
6. 150 gpm
7. 190 psi
8. Written communication, Texas Water Development Board

Tx-22

1. Mobil Oil Company
2. Coyanosa area northwest of Fort Stockton, Pecos County, Texas
3. 1966
4. A. about 6,250 ft.
   B. about 5,192 - 6,230 ft.
   C. Delaware Mountain Group - Sandstones - Permian age
5. About 8,400 gpd of produced brine, boiler blowdown, water-softener regenerator blowdown, and a mine regenerator blowdown and waste chemicals from gas treating plant. Waste flow rate will eventually be 21,000-42,000 gpd.
6. 84,000 gpd (58 gpm)
7. 650-700 psi
8. Written communication, Texas Water Development Board

Tx-23

1. El Paso Natural Gas Products Company, Odessa Petrochemical Complex (includes an olefin plant, a rubber plant, a butadiene plant, a styrene plant, a polyethylene plant, a chemical plant, a nylon plant, and an oil refinery).
2. 3 miles south of Odessa, Ector County, Texas
3. November 1965
4. A. 5,802 ft.
   B. 4,900 - 5,800 ft.
   C. San Andreas Limestone - Limestone - Permian age
5. Up to 1,600,000 gpd (1,100 gpm) cooling-tower and boiler blowdown water, process waste water, washdown water, and rinse and regeneration water from ion exchange units.

Chloride	3,000 ppm
Bicarbonate	1,000 ppm
Sodium	2,500 ppm
Magnesium	100 ppm
Sulfate	1,300 ppm
Total dissolved solids	8,000 ppm
pH	8.5

6. 900 gpm average 1,230 gpm maximum
7. 840 psi average 900 psi maximum
8. Written communication, Texas Water Development Board

Tx-24

1. Gulf Oil Corporation, Warren Petroleum Corporation, Como Gas Treating, Processing, and Sulfur Recovery Plant
2. Como Oil Field Area, Hopkins County, Texas
3. May 1965

Tx-24 (Continued)

4. A. 5,200 ft.
   B. 4,940 - 5,140 ft.
   C. Woodbine Group - Sandstone - Cretaceous age
5. Cooling-tower and boiler blowdown water, other plant process waste water, and brine produced from formations other than the Woodbine.
6. 20-50 gpm
7. 310-797 psi
8. Written communication, Texas Water Development Board

Tx-25

1. Shell Oil Company, Northwest Ozona Gas Plant
2. 2 miles northwest of Ozona, Crockett County, Texas
3. May 1965
4. A. 1,750 ft.
   B. 1,094 - 1,750 ft.
   C. San Andres Limestone - Limestone - Permian age
5. Cooling-tower blowdown water, process waste water, and zeolite regenerating wash water. Combined waste is largely inorganic salts with traces of hydrocarbons and H_2S. Total dissolved solids about 3,000 ppm, pH about 9.
6. 6-8 gpm
7. 300 psi
8. Written communication, Texas Water Development Board

Tx-26

1. Amarillo Oil Company, Pampa Gasoline Plant
2. 10 miles south of Pampa, Gray County, Texas
3. 1965 (?)
4. A. 1,000 ft.
   B. 925 - 1,000 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. Near saturated brine solution derived during "washing-out" an LPG storage cavern in the Clearfork salt interval at a depth of about 2,000 ft. Total dissolved solids about 270,000 ppm, pH 7.1. Waste production anticipated as 200,000 gpd (139 gpm) during construction of cavity.
6. Total of less than 700,000 barrels of brine in life of project.
7. Up to 300 psi allowable.
8. Written communication, Texas Water Development Board

Tx-27

1. Shamrock Oil and Gas Corporation, McKee Plant Complex
2. Northeast of Dumas, Moore County, Texas (see Tx-4-6)
3. 1965
4. A. ± 1,620 ft.
   B. 1,116 - 1,236 ft.
   C. Glorietta Formation - Sandstone - Permian age
5. Cooling-tower and boiler blowdown water and process waste water from oil refinery, gasoline plant, and petrochemical plant.
6. 500 gpm
7. 75 psi
8. Written communication, Texas Water Development Board

Tx-28

1. Mobile Chemical Company
2. 5 miles northwest of Port Acres, Jefferson County, Texas
3. 1965
4. A. 6,000 ft. (plug set at 5,100 ft.)
   B. 4,690 - 5,016 ft.
   C. Tertiary sands
5. 104-208 gpm of cooling-tower and boiler blowdown water, water treatment plant blowdown, steam drain water, contaminated storm drainage, and spillage from manufacture of terephtalic acid. Waste includes various organic acids, other hydrocarbons, and inorganic salts. Total dissolved solids 2,000-3,000 ppm, pH 3.0-4.0.
6. ---
7. 275 psi at 210 gpm during testing
8. Written communication, Texas Water Development Board

Tx-29

1. Shell Chemical Company
2. Deer Park, Texas
3. 1958
4. A. 7,650 ft.
   B. 7,152 - 7,533 ft.
   C. Frio - Sandstone - Tertiary age
5. Waste by-products from manufacture of phenol and waste brine containing 15% sodium chloride.
6. 35 gpm
7. Up to 400 psi
8. Donaldson, 1964

Tx-30 and Tx-31

1. E. I. DuPont de Nemours and Company, Victoria Plant (see Tx-7-10)
2. 4 miles northwest of Bloomington, Victoria County, Texas
3. 1967
4. A. About 4,200 ft.
   B. ---
   C. Lower Catahoula Sand - Tertiary age
5. ---
6. &7. Injection rates and pressure will probably be similar to Tx-7-10.
8. Written communication, Texas Water Development Board

Tx-32

1. E. I. DuPont de Nemours and Company
2. 2 miles south-southeast of West Orange, Orange County, Texas
3. April 1966
4. A. 5,230 ft.
   B. 4,550 - 4,660, 4,710 - 4,735
   C. Sands of Pliocene - Miocene age
5. Waste water containing 1.0% nitric acid, 2.3% organic acids, and 0.01% heavy metal salts.
6. 340 gpm average
7. 195 psi average
8. Written communication, Texas Water Development Board

WVa-1

1. E. I. DuPont de Nemours and Company
2. Belle, West Virginia
3. Probably late 1967
4. A. 1,500 ft.
   B. ---
   C. Salt sand (Pottsville Group) - Sandstone - Pennsylvanian age
5. Waste containing 15 to 25% NaCl and $CaCl_2$ and up to 5,000 ppm soluble organic compounds.
6. Expected to be 80 gpm
7. Expected to be 200 psi
8. Written communication, West Virginia Department of Natural Resources Division of Water Resources

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WVa-2

1. E. I. DuPont de Nemours and Company, Washington Works
2. Near Parkersburg, West Virginia
3. Not in operation January 1967
4. A. 1,682 plugged back to 1,490
   B. 1,334 - 1,448 ft.
   C. Salt sand (Pottsville Group) - Sandstone - Pennsylvanian age
5. Waste from teflon manufacture containing 6 to 15% hydrochloric acid, 100 ppm hydrofluoric acid, 2 to 5% formic acid, and up to 10,000 ppm organic chemicals.
6. Expected to be 100 gpm
7. Expected to be 400 psi
8. Written communication, West Virginia Department of Natural Resources, Division of Water Resources
   E. I. DuPont de Nemours and Company